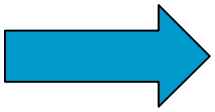
Status of TPC/HBD for PHENIX

Craig Woody
BNL

DC Upgrades Meeting
May 10 2002

Issues for the TPC/HBD PHENIX Upgrade

Need to prepare PHENIX LOI



Input to RHIC II CD-0 document (draft due 7/31/02)
BNL R&D proposal (due 9/20/02)

✍ Physics Issues

- **Measurement of low mass electron pairs and vector mesons**

  Weizmann HBD proposal (June 2001) lays out a strategy for Dalitz rejection needed to do this, but we need to state the *physics case* for making this measurement, including issues of rates, triggering, etc.
  (physics discussed by Itzhak in several talks, Tony's thoughts on trigger…)

- **Providing a new inner tracking detector for PHENIX**

  Need to make the case for improving global PHENIX tracking with an inner tracking detector (to do this right requires a *detailed* Monte Carlo)

✍ R&D Issues

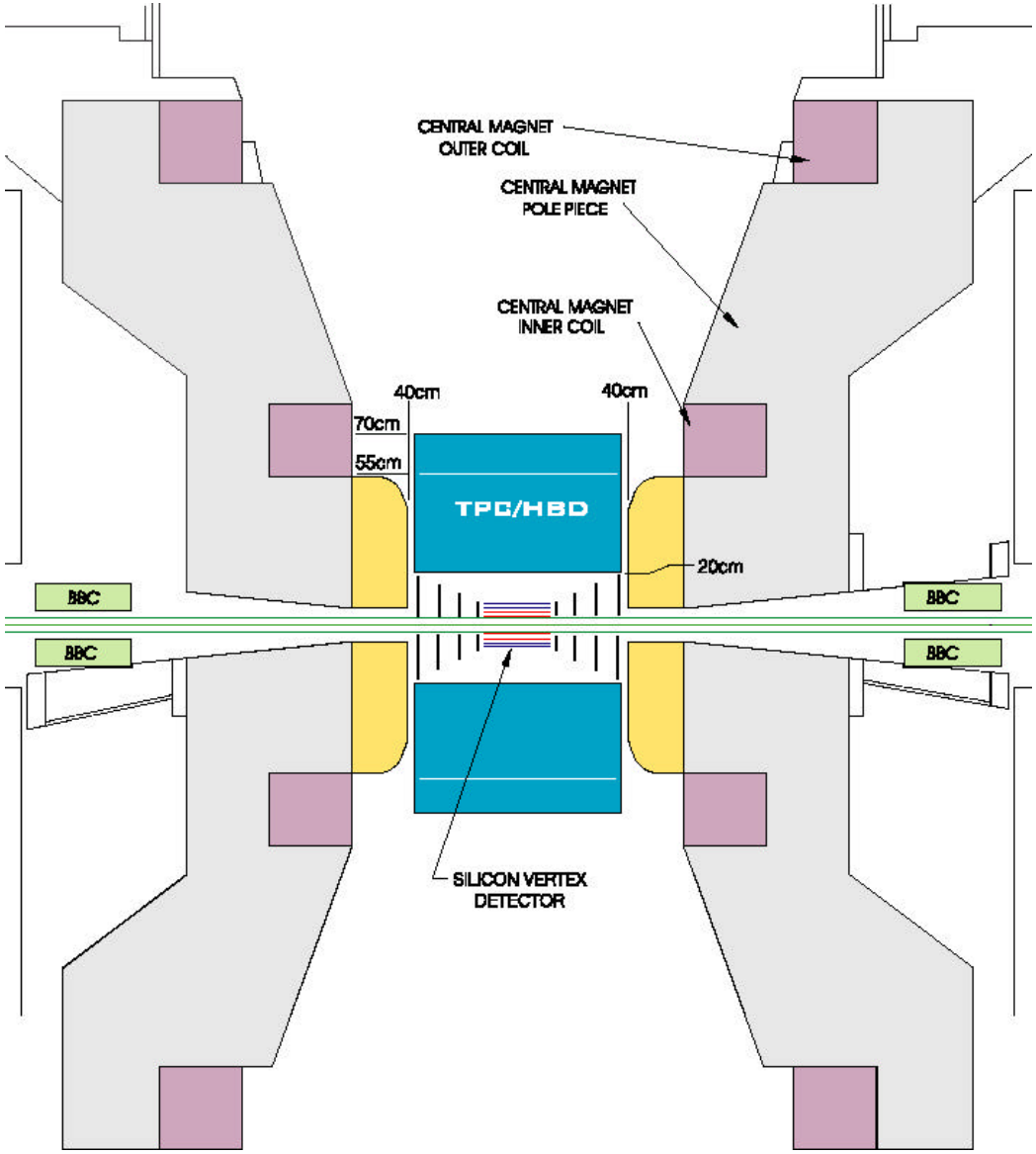
Interplay Between the TPC/HBD and the New Proposed Silicon Vertex & Tracking Detector

- The silicon vertex and tracking detector potentially adds a significant amount of material in front of the HBD which will increase the background for the electron pair measurement (see Christine Aidala's results)

- Can we provide the same level of *tracking* with the TPC with less mass, use it *in combination* with the HBD for the electron pair measurement, and get by with only a silicon *vertex detector* ?

- Must agree on geometrical boundaries for both detectors (e.g. r_{min})

- Can the silicon strip/pad tracking detector work for heavy ions ?


CENTRAL MAGNET
OUTER COIL
CENTRAL MAGNET
POLE PIECE
CENTRAL MAGNET
INNER COIL
40cm
40cm
70cm
55cm
TPC/HBD
20cm
BBC
BBC
BBC
BBC
SILICON VERTEX
DETECTOR

Multiplicities/event

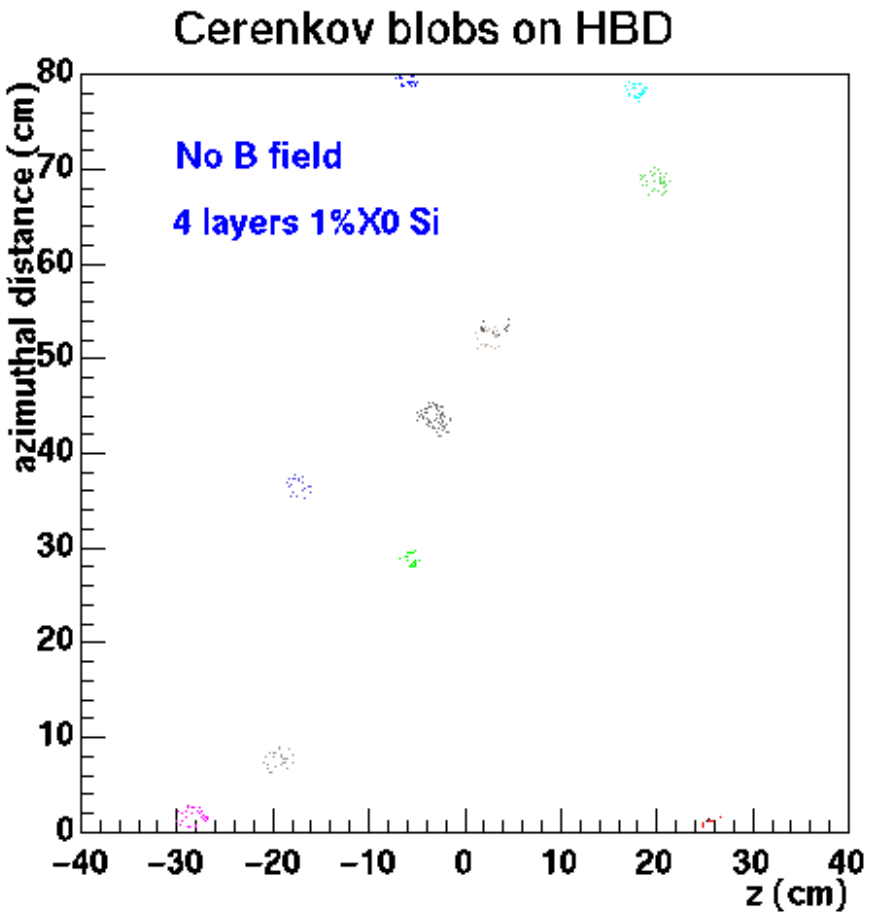
Min. 5 hits/track required in TPC from PISA; no field

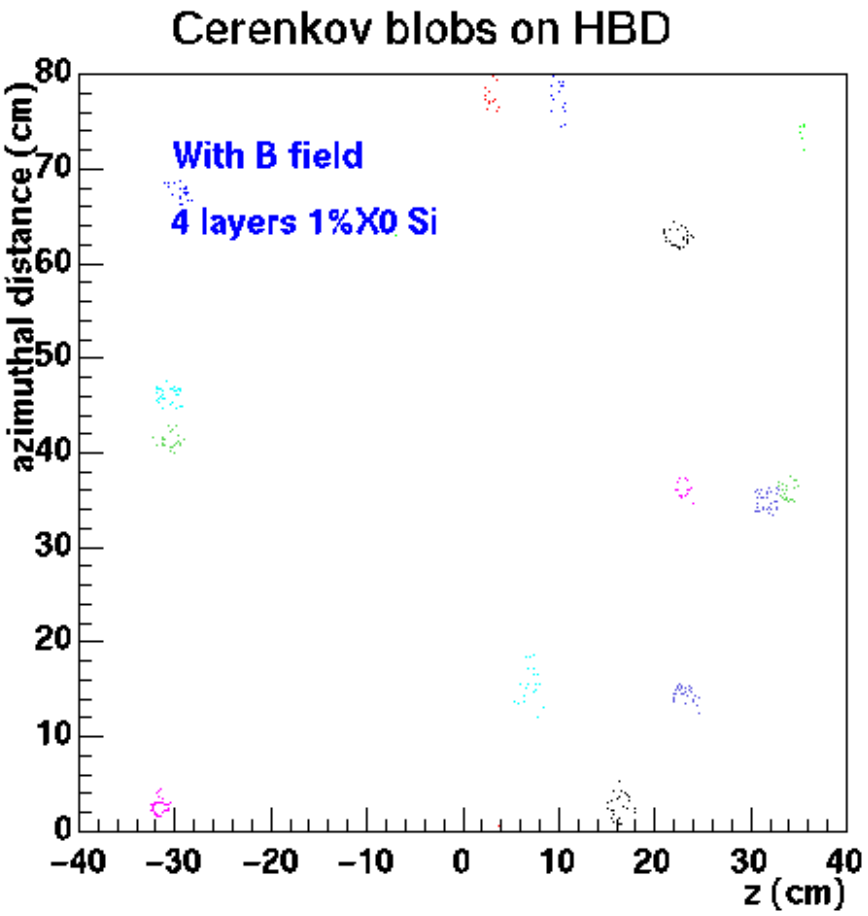
Particle species	EXODUS (averaged over 1000 evts)	+ beampipe and nosecones (1000 evts)	+ TPC/HBD (1000 evts)	TPC/HBD + 4 layers 1%X_0 Si (1000 evts)	TPC/HBD + 4 layers 2%X_0 Si (1000 evts)
All charged	1096.1	1107.3	1122.0	1161.7	1207.0
p/p-bar	57.6	58.6	60.4	63.4	65.3
K+-	92.7	92.1	92.3	90.5	89.2
pi+-	933.0	936.4	943.4	931.2	922.2
e+-	12.7 (9.1 Dalitz)	18.6	25.8	76.6	130.3

e+- Multiplicities/event hitting HBD

Averaged over 200 events	No Si	Si
No field (Tracking down to 1 MeV)	19.5	50.1
No field (Tracking down to 10 MeV)	17.5	43.9
No field (Tracking down to 20 MeV)	16.3	42.3
Field (Tracking down to 1 MeV)	28.4	59.8
Field (Tracking down to 10 MeV)	25.3	56.5
Field (Tracking down to 20 MeV)	22.6	51.6

Occupancy of HBD: 1%X_0 Silicon





C.Aidala, UWG, 4/18/02

The TPC as an Inner Tracking Detector in PHENIX

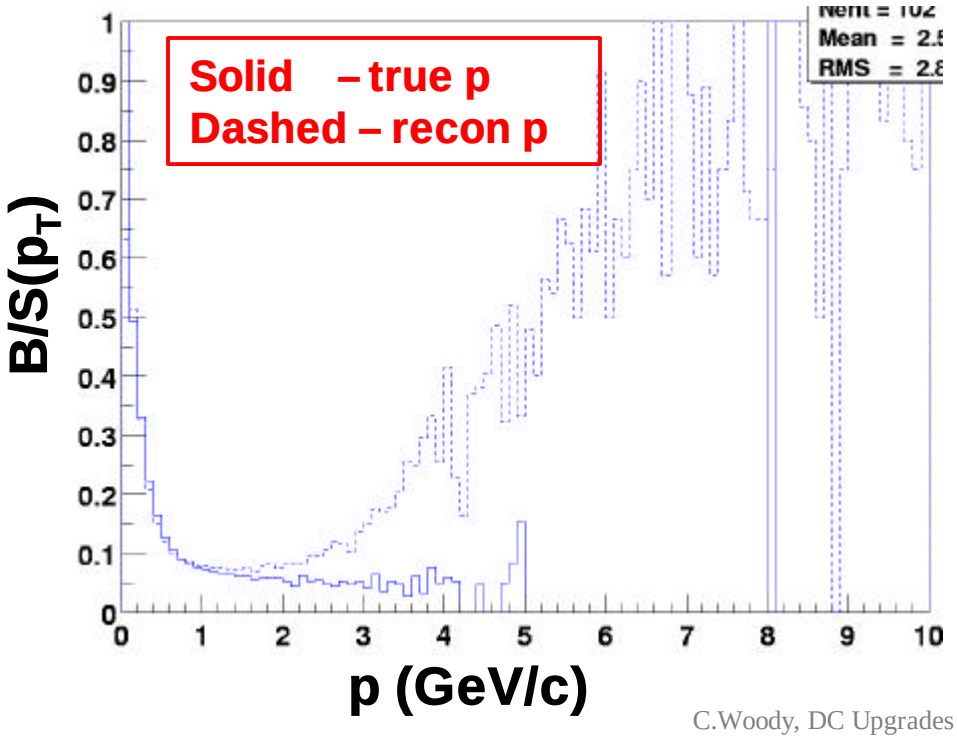
- Expect $\delta p/p \sim 2\%$ (300 μm or better space points, ~35 pad layers)
- Would provide tracking resolution comparable with the silicon tracker over 2π in azimuth and $|\eta| < 1$
- Tracking through the central field (in normal running conditions) would give better rejection against false high p_T tracks
  - second independent momentum measurement
  - can observe decays, conversions, etc…
- Tracking through the highly non-uniform "field free region" would give better association of Cherenkov "blobs" with electrons in the HBD
  - field would be optimized to measure low momentum tracks
  - could make effective mass cut rather than just opening angle cut
  - provides dE/dx information for e/π separation for p< 200 MeV/c

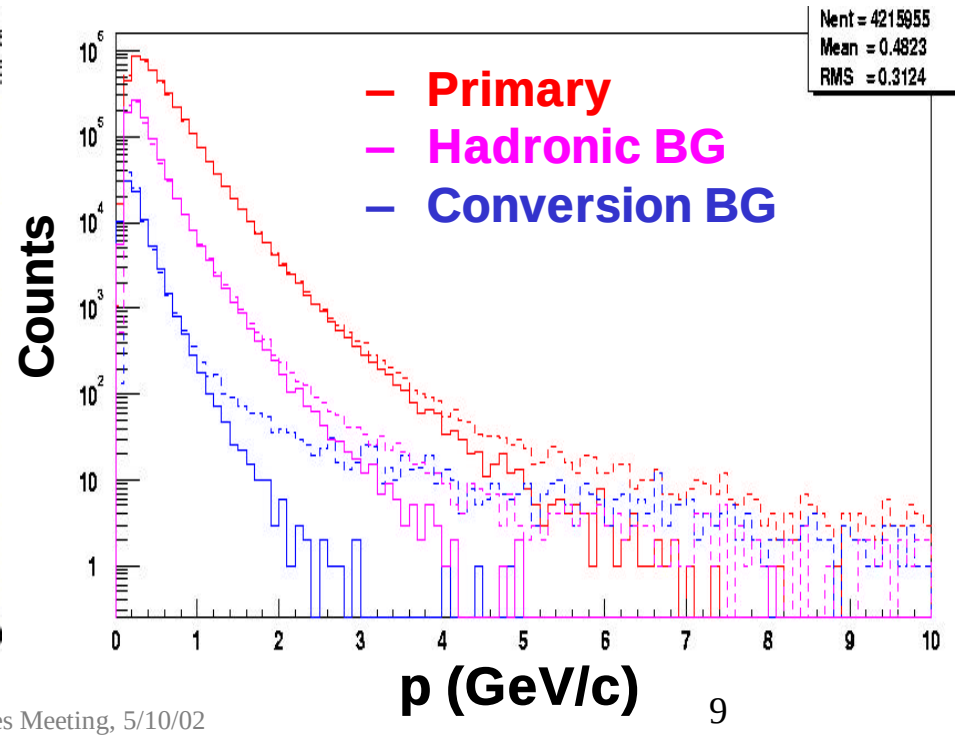
Charged High-p_T Analysis (2)

– The bad news

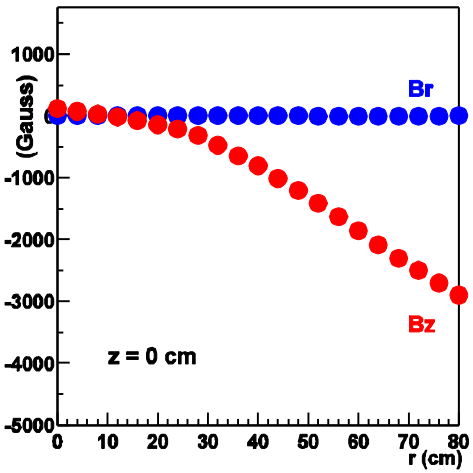
Brian Cole, Core Week Plenary, 5/8/02

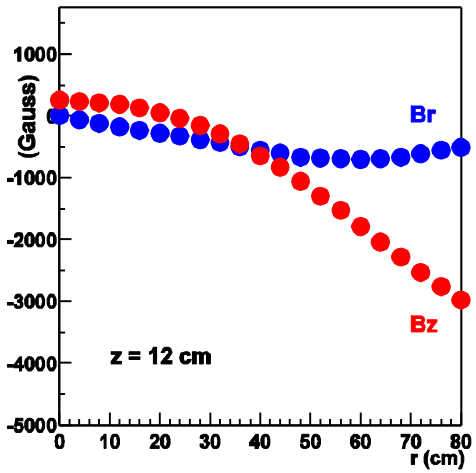
- Substantial background above ? (6) GeV/c.
- HIJING Monte-Carlo (100K events)
  - Low momentum photons, hadrons produce high-momentum reconstructed tracks

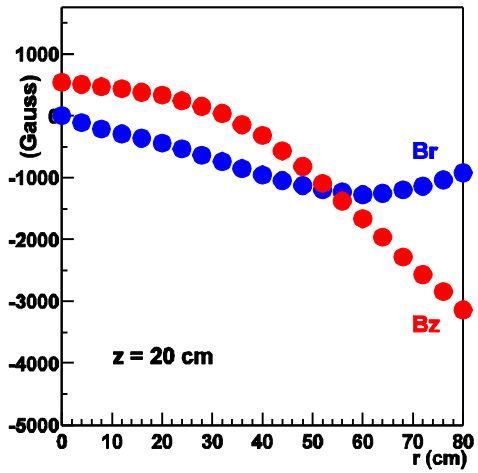


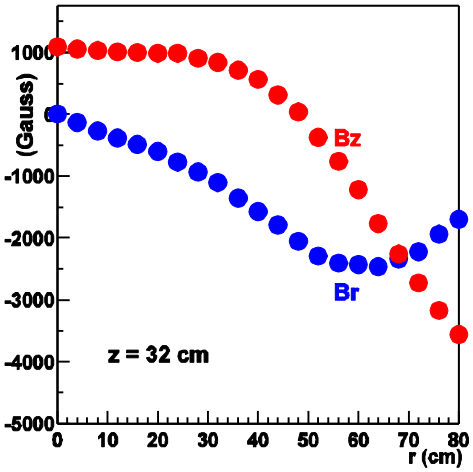


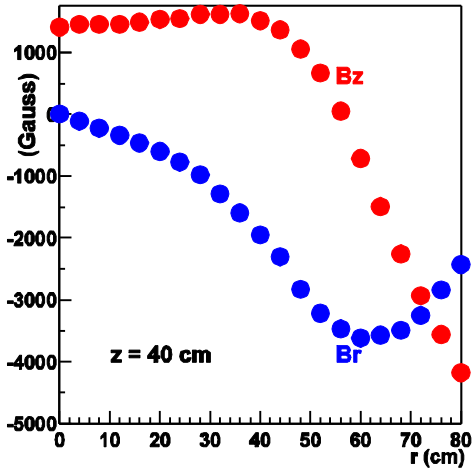
Field map, inner region (r < 80 cm)











New field map
-+ Coil Configuration

C.Aidala, UWG, 5/7/02

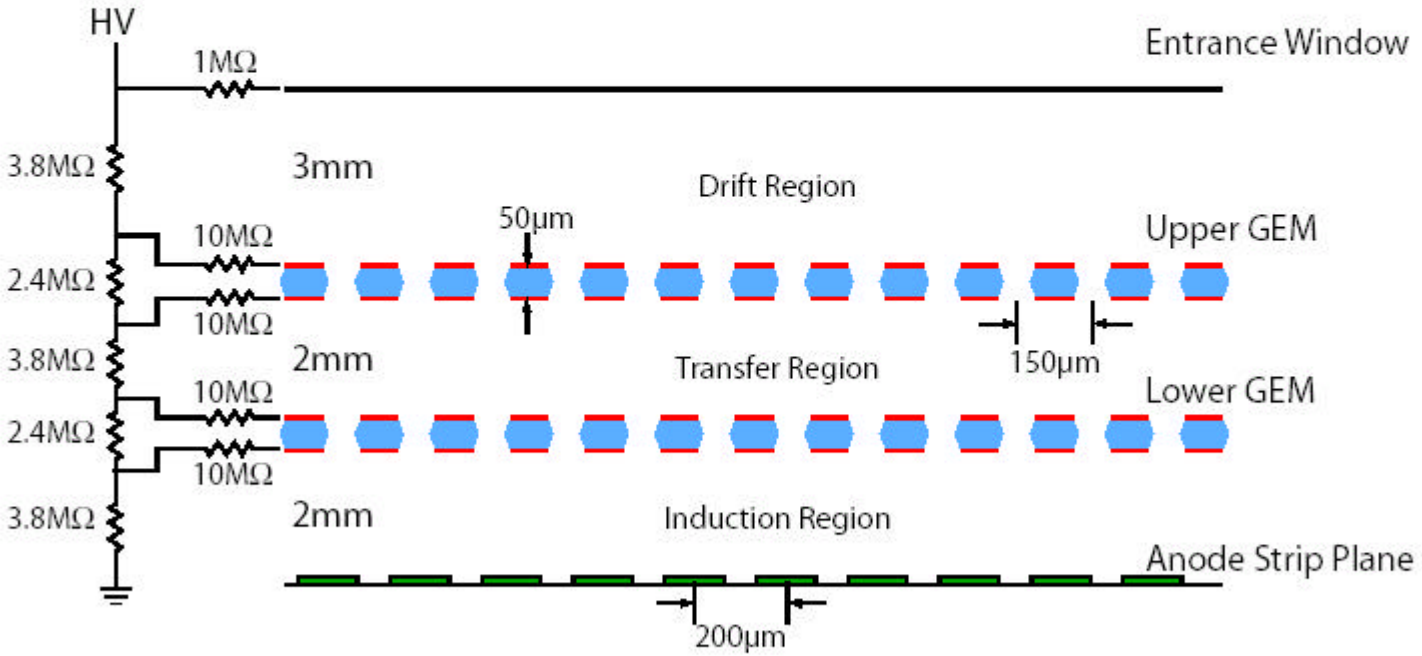
R&D Issues for the PHENIX TPC/HBD

- **GEM performance**
  - **proposed to be used in both TPC and HBD**
  - **current study has shown some effects which need to be understood (see Bo Yu's results)**
  - **how to get potentially excellent spatial resolution for the TPC in a cost effective way; needs a careful design of the readout plane + readout electronics**
  - **need to study and learn to build GEMs with CsI photocathodes (study under way – B. Azmoun)**

- **Need to understand the ExB effect in the TPC for drifting charge in the non-uniform magnetic field and it's effect on *pattern recognition***

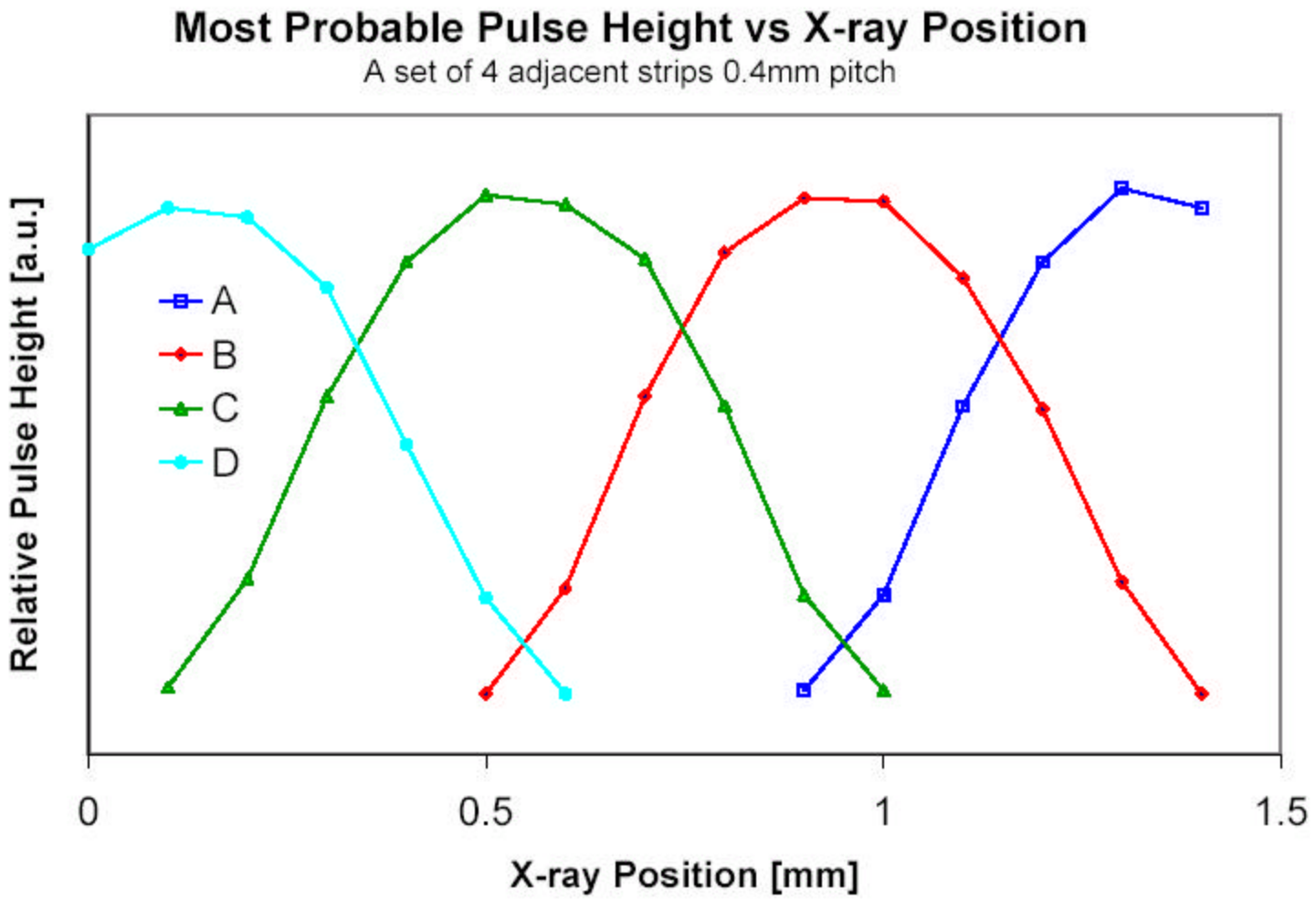
Double GEM Detetor Schematic Cross Section

(with resistive divider)

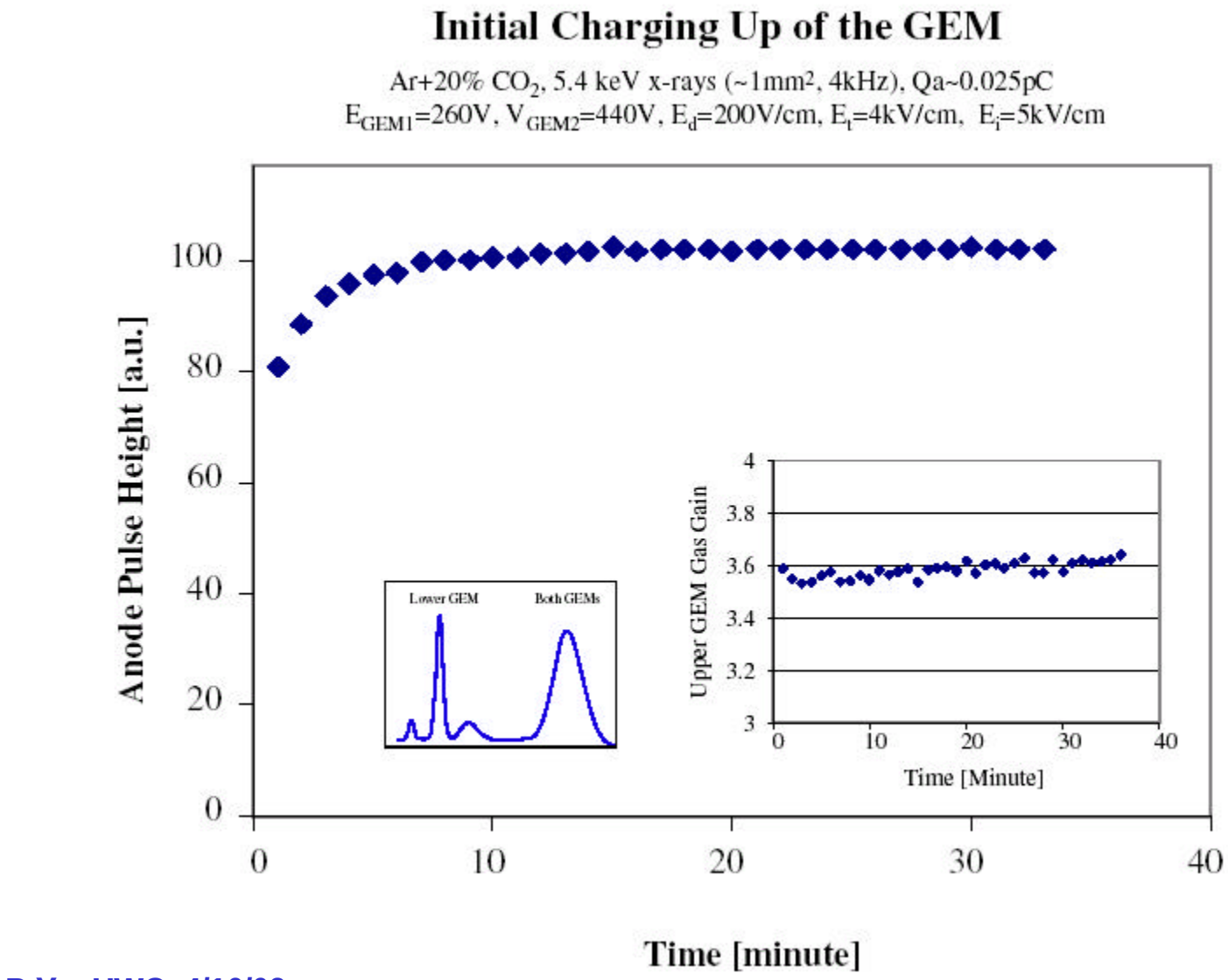


$V_{GEM} \sim 15\% V_W$

B.Yu, UWG, 4/16/02



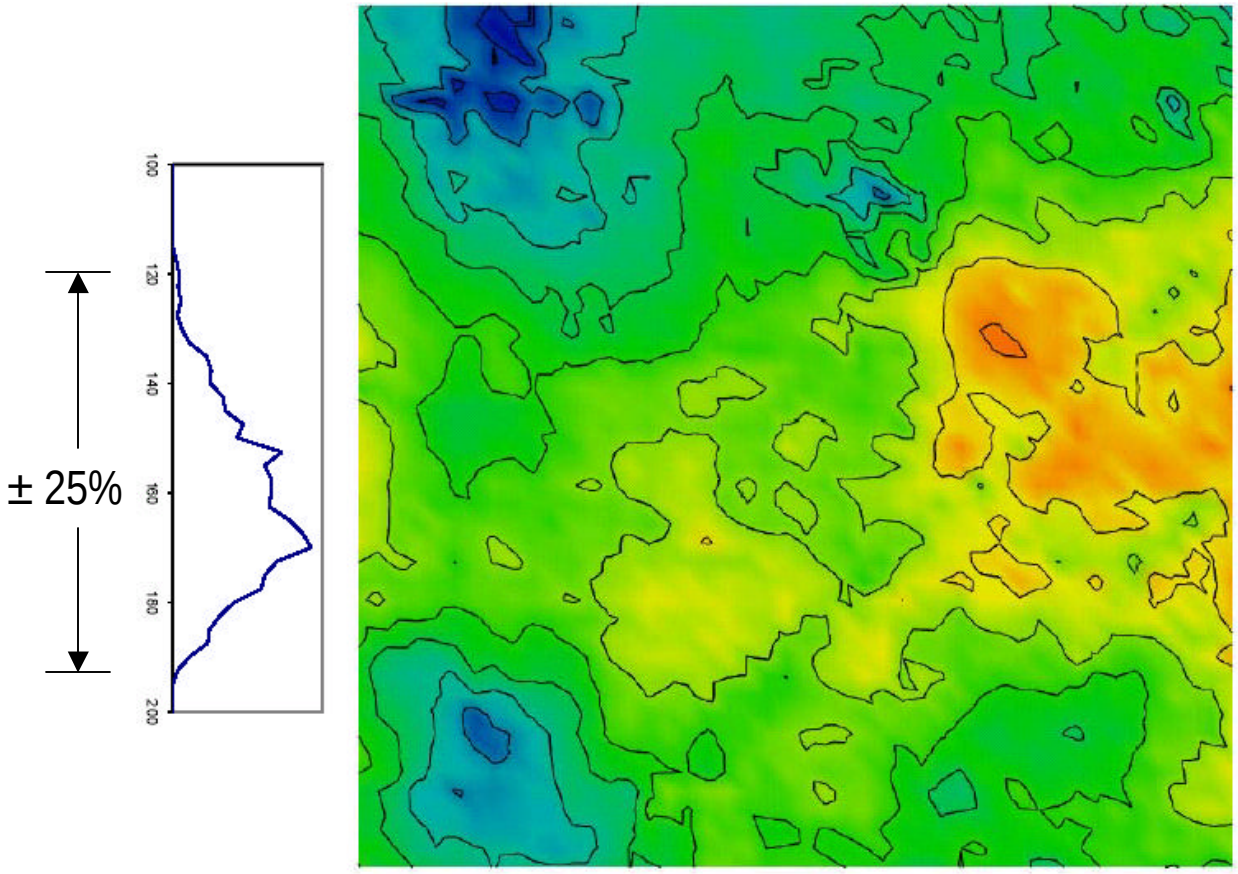
B.Yu, UWG, 4/16/02



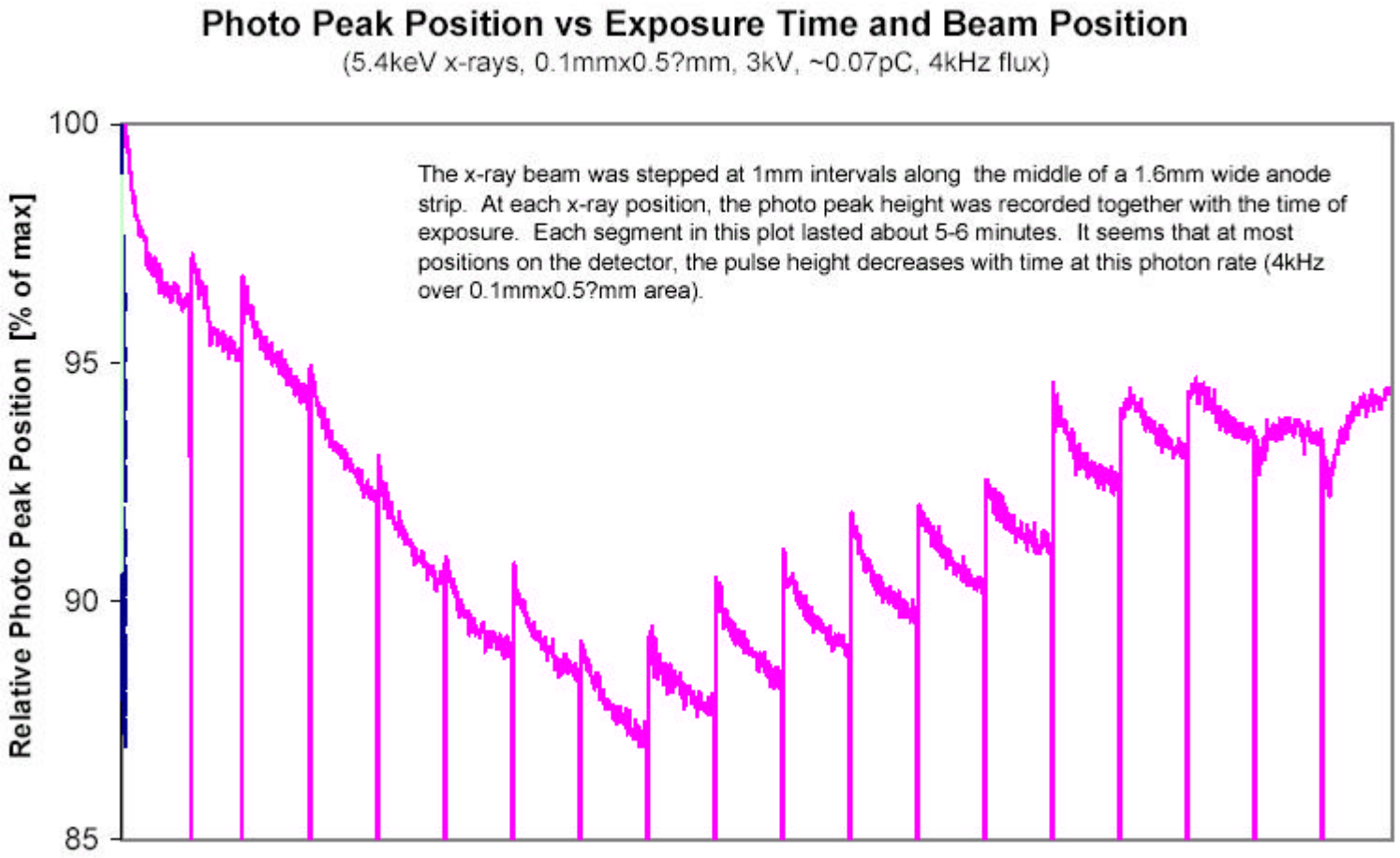
B.Yu, UWG, 4/16/02

Double GEM Gas Gain Uniformity

Collimated 5.4 keV X-ray, at 2mm x 2mm grid, 9cm x 9 cm area



B.Yu, UWG, 4/16/02



B.Yu, UWG, 4/16/02

Electronics Issues for the PHENIX TPC/HBD

- A significant effort will be required to developing new readout electronics for the TPC
  - new front end ASIC design
  - new FEM which will include zero suppression (same for silicon)
  - will probably take at least 2-3 years (once we get started)
  - will probably cost several $M

- Electronics for the HBD may be simpler, but will also require a fair amount of development
  - lower noise due to smaller primary signal, larger pads,…
  - must be low mass (part will sit in the PHENIX acceptance)

Manpower Issues for the PHENIX TPC/HBD

Institutions presently involved with this project

- BNL (Physics, Instrumentation)
- Weizmann
- Stony Brook
- Columbia
- University of Tokyo (CNS)
- Yale (STAR)
- LBL (STAR)

- New postdoc (Sasha Milov) coming to Stony Brook in June and will spend a fair fraction of his time working on upgrades
- Plan to hire a new BNL postdoc starting next FY to work on upgrades
- Hope to support new engineering effort starting next FY